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ABSTRACT

This study attempts to determine if the stimulus generalization concept is applicable to school-relevant instruction when the material to be learned is verbal science information. The delivery techniques under investigation were audio, printed, and a simultaneous combination of both media. Three hundred and thirteen tenth grade biology students were randomly assigned to nine groups and a variation of the posttest-only control groups experimental design was used. Each group was tested over the presented information using one of the three delivery techniques. Both learning and evaluative materials were presented using a programed text format group-paced delivery technique. Analysis of covariance indicated no advantage in using the same media in the learning and testings sessions. The Verbal Reasoning Test scores of the Differential Aptitude Tests served as the covariate scores. These findings question the extent of the theory's applicability and usefulness to meaningful prcse material in science, especially where the instruction more closely approximates school-relevant conditions at the secondary school level. (Author/CP)

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CLASSROOM APPLICABILITY OF THE STIMULUS GENERALIZATION CONCEPT TO VERBAL SCIENCE INFORMATION

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Smith, Schagrin and Poorman (1967) examined multi-media systems with particular emphasis on instructional programs developed in science education. They concluded that many claims have been made regarding the effects of multi-sensory systems on learning. However, little rigorous research has been performed on these so-called rules that are intended to guide the developers of multi-media systems. These authors found this lack of properly supported theory was a hardship to the development of a multi-media system pilot project adjunct to Harvard Project Physics.

The use of multi-media systems in the classroom will be more prominent in the future as more and more schools turn to individualized instruction as a means of teaching science (NSTA, 1971). However, most of the research in the area has either concerned itself with single-concept stimuli or it has failed to meet minimal research methodological criterion (Holliday, 1971). There exists an obvious need to examine the components of multi-media systems in science education (Koran, 1970) in terms of an evolving theory. The author of this paper has investigated one of these theories as it relates to verbal instructional materials in science.

Hartman has defined the stimulus generalization (SG) concept in terms of audio-visual communication practices. He states that the learning of information increases as the medium used in the testing situation becomes more similar to that in the presentation (Hartman, 1961b). Consequently, this theory "would predict that maximum learning for any combination of testing channels will be highest when the presentation situation is identical with the testing situation" (Hartman, 1961b). In other words, decreasing gradients of information gains should result from differing the testing medium in the opposite direction to that of the presentation stimulus.

Hartman (1961a) investigated this concept by exposing Ss to twenty-five randomly selected items from a larger pool of seventy-five common Anglo-Saxon names. The Ss were tested by requiring them to recognize which names from the larger pool had been included in the presentation series of twenty-five items. In the verbal portion of the experiment nine treatment groups were presented twenty-five names through one of the three delivery systems - audio, printed or the combination (audio and printed) instructional mode. Subsequently, each treatment group was administered a true-false test using one of the three delivery techniques. The experimental design used in the present study is similar to the one used by Hartman. The results of Hartman's

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experiments were partially consistent with the stimulus generalization theory. When the printed test was used, the results were consistent with the theory. When the audio and printed test was used, only the audio and printed presentation proved to be superior to the audio presentation of the same information. When the audio test was used, no significant differences were detected among the three presentations.

Hartman (1961b), reviewed audio-visual communication articles relevant to the SG theory. Most of the studies mentioned either used single-concept stimuli or they examined situations of limited value to classroom conditions. For example, the treatment conditions cited by Hartman consisted of learning action words, names, letters and digits, pairing of words and pictures and knot tying techniques as viewed from different camera angles. These were typical examples of the learning situations required of Ss.

Subsequently, Severin (1967a) investigated the cue summation theory and related it to SG. The cue summation theory states that information gain will only occur in a multi-media presentation in comparison to a single channel system, if additional cues or stimuli are present in one of the two channels. His experiment was based upon the assumption that the SG theory was operating as defined by Hartman. Together, SG and cue summation predict that an increase in the number of cues available in the communication of information increases the information gain from that communication, provided the cues are also available in the situation where the gain is tested (Severin, 1967b). Conway (1968), in a review of multiple-sensory modality communication and sign type differences, has seriously questioned the validity and the applicability of the SG concept. Hartman and Severin in their media research have supported this theory and assumed it to be valid without empirically investigating its utility, according to Conway. He has called for school-relevant research in which the learning materials and the experimental setting more closely approximate that of the classroom. Because of the potential applicability of this theory to individualized instructional programs in science, an attempt has been made to clarify the appropriateness of the SG concept to secondary school students learning verbal science information. The question of interest in this study was: Is the SG concept applicable to school-relevent instruction, if the material to be learned is verbal science information? The media or delivery techniques under investigation were audio, printed and a simultaneous combination of

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both media. This experiment was designed to examine the comparative effects of the different media using redundant information of the same sign type in the presentation and the testing situations as prescribed by Conway, thereby minimizing the extraneous information variable in this initial experiment.

Three hypothetical principles in biology and a comprehension test were developed for this study in an attempt to prevent the verbal printed component from singularily dominating the sensory channels of the learner. Two of the principles were concerned with two unique ways of categorizing difficult parts of organisms. The third principle was concerned with uniquely categorizing different organisms in accordance with two common characteristics of living things. Obvious examples of the principles were used as illustrations. The three principles were based upon factual information. The only reason biologists do not use the hypothetical classificatory ideas is because there has not been established any particular need to categorize different parts of organisms and different kinds of living things in the way described by the hypothetical principles.

Hartman (1961b) and Duker (1965) have stated that more difficult verbal information is less effectively presented using an audio medium. Therefore, relatively easy verbal information consisting of common sentence patterns and comprehensible vocabulary were utilized in the construction of the principles and the test. The principles and test were evaluated in terms of Fry's Readability Graph (Fry, 1968) and found to rank at the eighth grade level. If traditional concepts would have been used, this would have more likely resulted in information jamming as described by Hsia (1971). This type of learning material has permitted the investigator to develop a twenty item true-false test that required Ss to perform tasks associated with concept learning, rule learning and problem solving as defined by Gagne (1970). Since the experiment required one-third of the Ss to use the audio medium in the testing sessions, a true-false test was considered to be most appropriate. The other reason for using this type of question was to maximize the similarities between treatments, except for the delivery technique.

A pilot program involving ninety-nine Ss was administered in a nearby school. This pilot phase was conducted to determine the appropriateness of the administrative aspects of the experimental procedure and to subject the resulting test data to an item analysis. The item content of the retention test used in the experimental phase was based upon the results of this analysis.

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Three hundred and thirteen tenth grade biology students were randomly assigned to nine subgroups. A variation posttest only control group experimental design was used. Each subgroup was presented the information through one of the three delivery techniques. Subsequently, each subgroup was tested over the presented information using one of the three delivery techniques. In other words, these nine subgroups were identifiable by the unique combination of media utilized for each in the learning and subsequent testing sessions. A table illustrating the design can be found in Appendix A. For example, the printed (learning) and audio-printed (testing) subgroup learned the science information by silently reading the text and were tested by silently reading the test and by simultaneously listening to the test read aloud. Both the learning and evaluative materials were presented using a programed text format group-pace delivery technique.

Analysis of Covariance was used to test the probability of significant difference between the adjusted means. The Verbal Reasoning Test scores of Differential Aptitude Tests served as the covariate scores. Analysis of covariance indicated that there was no learning advantage in using the same media in the learning and testing sessions. The resulting data were analyzed in two ways. First, three analyses among the adjusted means of each testing media were made. Second, six a priori orthogonal comparisons of pairs of adjusted means were made. The hypothesized rank order of adjusted group means is located in Appendix B. The results of both analyses can be found in Tables One through Nine in Appendix C.

All Ss were informally asked which combination of techniques, if any, they preferred. Most Ss claimed that the combination media was "best". The remaining Ss were approximately split evenly as to whether the audio or the printed media delivery technique was "best". The subjects indicated a preference for the same combinations of delivery systems as would be predicted by the SG theory. However, it is recognized that this kind of survey is not necessarily sound and one must be cautious in making interpretations from it.

Can the SG concept assist developers of science instruction in making decisions about the most appropriate media for a testing situation in particular context? The results of this experiment do not lend support to the applicability of this theory's usefulness to meaningful prose material in science education, especially where the instruction more closely approximates school-relevant conditions at the secondary level. Considering the sample size, the experimental design, and the administrative procedures, there is little likelihood that the differences among the treatment subgroups in this experiment would have been of any consequence.

The empirical findings obtained by audio-visual communication researchers do not conflict with the result of this particular experiment. It must be remembered that these researchers were asking different questions. The experiment under discussion was designed to examine the comparative effects of the different media using redundant information, thereby minimizing extraneous information variables. In Hartman's review of what he calls SG, Ss were required to perform motor chaining tasks and verbal association tasks. Both the chaining and most of the verbal association studies support Hartman's conceptualization of SG. His carefully controlled verbal association study failed to completely support the SG theory, as previously discussed. Ss in the present study were asked to perform concept learning, rule learning and problem solving tasks. One explanation for the differences in experimental findings as related to the S G concept might be inherent in the position of the task within the learning hierarchy. As the learning tasks became more complex, the intermediate events between the stimulus and the response situations probably became more complex and relatively less dependent upon the similarity between media used in the presentation and the teaching situations.

Another factor effecting the learner's dependency upon the similarity of the media probably is related to the type of material to be learned. Since only one sign type was used in the presentations and testing situations (i.e. digital), it was not necessary for the learner to translate across sign types. If the learner would be required to translate from one sign type to another, the SG theory might have been manifested in the experimental results.

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APPENDIX A

MODEL OF THE STUDY

Mode I	Learning Session Delivery Technique	Audio	Audio Printed	Printed
	Testing Session Delivery Technique	Audio Mode of the Retention Test		
Mode II	Learning Session Delivery Technique	Audio	Audio Printed	Printed
	Testing Session Delivery Technique	Audio-Printed Mode of the Retention Test		
Mode III	Learning Session Delivery Technique	Audio	Audio Printed	Printed
	Testing Session Delivery Technique	Printed Mode of the Retention Test		

The nine subgroups are identifiable by the unique combination of delivery techniques utilized in the learning and testing sessions.

APPENDIX B

HYPOTHESIZED RANK ORDER OF ADJUSTED GROUP MEANS

Learning Session Delivery Technique	Testing Session Delivery Technique	Hypothesized Rank Order of Adjusted Group Means
Audio	Audio	1
Audio Printed	Audio	2
Printed	Audio	3
Audio	Audio Printed	Lower than one
Audio Printed	Audio Printed	1
Printed	Audio Printed	Lower than one
Audio	Printed	3
Audio Printed	Printed	2
Printed	Printed	1

APPENDIX C

TABLE ONE

COMPARISON OF THE ADJUSTED GROUP MEANS FOR AUDIO FORM OF THE RETENTION TEST: ANALYSIS OF COVARIANCE TABLE

Source	df	F-ratio	Probability
Total	104		
Groups	2	1.85	.161
Error	102		

TABLE TWO

COMPARISON OF THE ADJUSTED GROUP MEANS FOR THE AUDIO-PRINTED FORM OF THE RETENTION TEST: ANALYSIS OF COVARIANCE TABLE

Source	df	F-ratio	Probability
Total	102		
Group	2	1.49	.228
Error	100		

TABLE THREE

COMPARISON OF THE ADJUSTED GROUP MEANS FOR THE PRINTED FORM OF THE RETENTION TEST: ANALYSIS OF COVARIANCE TABLE

Source	df	F-ratio	Probability
Total	107		
Group	2	.01	.989
Error	105		

TABLE FOUR

COMPARISON OF THE ADJUSTED GROUP MEANS OF THE
AUDIO AND AUDIO-PRINTED LEARNING PRESENTATION FOR THE
AUDIO FORM OF THE RETENTION TEST: ANALYSIS OF COVARIANCE TABLE

Source	df	F-ratio	Probability
Total	70		
Group	1	.42	.5282
Error	69		

TABLE FIVE

COMPARISON OF THE ADJUSTED GROUP MEANS OF THE
AUDIO-PRINTED AND PRINTED LEARNING PRESENTATION FOR THE
AUDIO FORM OF THE RETENTION TEST: ANALYSIS OF COVARIANCE TABLE

Source	df	F-ratio	Probability
Total	69		
Group	1	1.63	.2040
Error	68		

TABLE SIX

COMPARISON OF THE ADJUSTED GROUP MEANS OF THE
AUDIO AND AUDIO-PRINTED LEARNING PRESENTATION FOR THE
AUDIO-PRINTED FORM OF THE RETENTION TEST:
ANALYSIS OF COVARIANCE TABLE

Source	df	F-ratio	Probability
Total	68		
Group	1	.06	.8084
Error	67		

TABLE SEVEN

COMPARISON OF THE ADJUSTED GROUP MEANS OF THE
AUDIO-PRINTED AND PRINTED LEARNING PRESENTATION FOR THE
AUDIO-PRINTED FORM OF THE RETENTION TEST:
ANALYSIS OF COVARIANCE TABLE

Source	df	F-ratio	Probability
Total	65		
Group	1	1.49	.2249
Error	64		

TABLE EIGHT

COMPARISON OF THE ADJUSTED GROUP MEANS OF THE AUDIO AND AUDIO-PRINTED LEARNING PRESENTATION FOR THE PRINTED FORM OF THE RETENTION TEST: ANALYSIS OF COVARIANCE TABLE

Source	df	F-ratio	Probability
Total	71		
Group	1	.02	.8954
Error	70		

TABLE NINE

COMPARISON OF THE ADJUSTED GROUP MEANS OF THE AUDIO-PRINTED AND PRINTED LEARNING PRESENTATION FOR THE PRINTED FORM OF THE RETENTION TEST: ANALYSIS OF COVARIANCE TABLE

Source	df	F-ratio	Probability
Total	68		
Group	1	less than .01	.9836
Error	67		